# SCIENCE

VOL. LXV APRIL 1, 1927 No. 1683

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**SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by**

**THE SCIENCE PRESS**

**Lancaster, Pa. Garrison, N. Y.**

**New York City: Grand Central Terminal.**

**Annual Subscription, $6.00. Single Copies, 15 Cts.**

**SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.**

**Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.**

## RESEARCH IN COLLEGES AND PROFESSIONAL SCHOOLS[1]

### INTRODUCTORY NOTE

IT was planned to introduce this program with a paper by Dr. John C. Merriam upon "Research as revealing an Attitude of Mind," but illness in his family prevented his being present or sending his paper.

A few college presidents and university professors have expressed the feeling that men qualified to do worthy research are rare, and that most college teachers would do well to let research alone and stick to their teaching. We who have been endeavoring to promote research in colleges have had a fundamentally different view, and it seems well to outline it briefly as a background for the discussions to follow.

We believe that every normal individual is born with some endowment of the research spirit—the inquiring mind given to trying to find out by exercise of its own powers. Normal children are full of natural curiosity and they have to a fair degree the habit of experimenting; that is, they are endowed with something of the research spirit.

We believe that this mental habit of learning by self-reliant experiment should be conserved and strengthened from the beginning throughout life. We believe that all education, from pre-kindergarten age on through the university, should have this encouragement of the spirit and habit of research as a main object. We believe that no worth-while job in life can be done with proper effectiveness in any other spirit. We believe that, in all education, learning through self-reliant experiment and exercise of individual judgment should dominate and that the habit of stopping with faith in the printed statement in the text-book should be avoided as leading to fatty degeneration of the mind and soul. We believe that teaching should be conducted only by those who have the research attitude themselves and have ability to cultivate it in their pupils.

Men with the research spirit are now available for the colleges, and from among university graduates are coming new men who, though wrongly trained in their earlier school studies, have later come into contact

[1] A series of papers arranged by the secretary of the committee on research in educational institutions, a subcommittee of the committee of one hundred of the American Association for the Advancement of Science, given at the Philadelphia meeting on December 28.

with the research spirit in the university and have presumably imbibed something of this spirit. We believe it to be vitally important to the colleges to encourage in every way in their power the spirit of research in their teachers.

It is equally important for the schools of all grades, but their problem is one of much greater difficulty, for they draw their teachers chiefly directly from the excessively pedagogic and therefore deadening atmosphere of the ordinary schools and normal schools rather than from among university graduates. We have, therefore, given our attention chiefly to the colleges, a phase of our educational system apparently now most ready for improvement. Conditions in professional and technical schools need as serious consideration as those in colleges.

In brief, so far as the American college is concerned, our main purpose is to change somewhat fundamentally its intellectual atmosphere, to set up a new standard, so that hack teachers will be barred and young men and young women at the time they are determining their life interests shall be in contact with teachers of scholarly habit and some scholarly attainment. This is a far-reaching program, requiring time and much money for its attainment. The first essential step is to see clearly the goal and to revaluate college customs, ideals and methods in view of this larger conception of college excellence.

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## RESEARCH IN MEDICAL SCHOOLS

THE subject of starting medical students in research may well lead to discussion, for opinion now varies all the way from the theory that none should try research up to the idea that every medical student should undertake a problem. In the presentation of the subject as I see it, it will be well to make clear at the outset that one of the elements of liberty in education is freedom for the individual teacher to carry out his own ideas; in other words, outstanding ability for teaching and especially for leading students into research has so large an element of natural gift or creative talent that methods must vary with each teacher.

Medical schools, as they are organized to-day, have three functions: There is first their original purpose of training practitioners of medicine. Second, as professional schools, they must perpetuate themselves by training their own teachers. Third, they must carry their share of the progress of medical science in laboratory and hospital not only through the work of their own teachers but also by training those who are to carry on investigation in research institutes.

As is well known, every science passes through two phases, the descriptive and the experimental. In an address on the late Sir William Osler, Dr. Rufus Cole gave a delightful description of Osler's clinic as an example of teaching medicine in its descriptive phase. During the years from 1893 to 1900, Osler's wards in Baltimore were filled with typhoid fever in the fall, with pneumonia during the winter. In the clinic he had a large blackboard for the permanent records of the term, a line for each case with such essential facts as onset, temperature, complications, etc. The student kept a duplicate list and elaborated his notes at each ward round where he studied the cases and at each clinic where new symptoms were reported and discussed. At the end of the term, the student analyzed the data from his own notes into terms of the percentage of complications, the range of temperature, the duration of the disease, the mortality; in other words, each student wrote a text-book of typhoid fever from the cases he himself had seen, examined and recorded and then compared the findings of his own particular season of typhoid fever with the experience of other years and with the percentages from larger numbers. In this method, carried out with all the charm of Osler, the student became the physician at his very first clinic and started in the method by which he was to become a permanent student of medicine. Thus he had training in the essential methods of a descriptive science, observation, record and the periodic analysis of data.

I have taken this illustration from clinical teaching rather than from the laboratory because in the laboratory it was established even earlier that the student should gain experience from specimens which he himself prepared and studied, that he should analyze his own material and compare his results with the records in his text-book and in the literature. It may now be taken for granted that the method of descriptive science—observation, record, analysis—are so firmly intrenched in the fundamental courses given to all medical students that every single student in medicine must realize that the days when medicine could adequately be described as the art of healing have gone forever, for to the fine skill of dealing with patients has been added the application of the methods of a rapidly advancing science.

To meet the needs of this advancing science, how shall we introduce students into research? There are first those who believe that the demands of the medical course are so great that no student should undertake research until he has won the medical degree. To this idea is added the opinion that no student can have a sufficient mastery of the literature of any

phase of medical science to warrant his starting in research. In advocating my own theory, that the exceptional student, and by this phrase I mean the student with exceptional bent toward research, should be encouraged to undertake a problem during the medical course, these objections seem to be of little weight. In the first place, the medical course, like every other educational course, is actually organized so that the average student gets through, as is amply proved by the fact that in medicine, as in all other professions, only a few show outstanding ability. It goes without saying that the exceptional student can do more than the average and a student selected to do research should be able to carry the regular work with ease. If an occasional student has an interest so exclusively limited to some problem that he can not also carry the course, he can readily work for the degree of doctor of philosophy in the medical sciences and thus limit the amount of general work to the minors required for that degree.

As far as mastery of the literature is concerned, any person beginning research must depend at the outset on the one who formulates a problem on which he can start as a next feasible step in the progress of medical science. In our own time, when scientific journals have multiplied in number to such an extent that any investigator could occupy his entire time with reading to the exclusion of original research, we will do well to recognize, first, that professional research workers themselves do make use of such cooperative endeavor in the mastery of literature as is represented in such journals as *Physiological Reviews* and that the effort to gain complete mastery of literature is more often concerned with the minor issue of priority rather than the major issue of the advancement of science. That work, sometimes most valuable work, is frequently overlooked is well illustrated in the well-known example of Mendel and has recently been brought out by Dr. Arnold Rich in a delightful account of Dutrochet, until now practically unknown, and yet it was he who first formulated the cell theory fifteen years before the work of Schleiden and Schwann. Rich points out that frequently new concepts are ignored and rejected because the age in which they appear is not sufficiently advanced to comprehend them. To this we may add that the lesson for the investigator is that effective presentation of research involves not only the facts but also their bearing and whither they lead as far as he himself is able to discern. In connection with this concept of a supposed complete mastery of the literature, it seems to me that often the most original minds, the minds most adapted to experimentation, are not the types that enjoy analysis and classification of vast masses of detail in knowledge. In looking back over one's own education one can easily recall two kinds of teachers, one who presented the critical analysis, the classification and organization of data and the other whose interest was concentrated on the growing zone of knowledge. That both types of instruction are valuable to the student is clear; I only wish to bring out the folly of trying to force both methods of work into the one individual. There are investigators who start with a masterly concept of known facts; there are others, equally valuable, often more original, who prefer to analyze the detail of literature when their work is already well under way. Certainly in an age where extreme democracy in education tends toward standardization, we might well consciously give the investigator the freedom of his individuality. My plea for the student is that he may depend on a few of the outstanding contributions on his proposed subject and a few of the newer articles that show him how the subject is growing at the moment, to give him an adequate start and that any supposed complete mastery of literature will be acquired by him, if at all, only by long years of study. Moreover, the beginning of a problem of his own will serve to stimulate as well as to give direction and purpose to his reading.

In contrast to the idea that no student should undertake a problem there are medical schools organized on the basis of research for every student. This means the attempt to organize the work for the medical degree on the same basis as the work for the degree of doctor of philosophy. This method has the advantage in argument that it is now being carried on with success and comes under my original proviso of liberty for the teacher; nevertheless, I wish to express what seem to me to be weaknesses of the system. In medical schools as they are now organized, only a part of the students are to become professional research workers and yet it is perfectly clear that every student, whether preparing for practice, teaching, or research should have the methods of science. That much should be cared for as indicated above in the entire system of medical education. But, when every student is assigned a problem, much of the work, indeed I think one could say the majority of the work, will turn out to be the writing of an essay instead of the presentation of the results of original investigation. This I think will be true for two reasons, first the limitations of the students themselves and second the limitations of the capacity of any faculty for directing research. It is in my opinion entirely feasible to train every single student in a medical school in the methods of descriptive science; but medicine has passed far beyond the stage of a descriptive science, it is now in the experimental phase and the need of the medical school of to-day

is to furnish a certain number of professional research workers in experimental medicine.

This is the problem of our day; the problem of changing medical education from an art to a science was attacked thirty years ago when the laboratories became so dominant, but to-day it is the need of medicine as an experimental science that must occupy educational thought. The story of medicine of the last fifty years has completely committed the medical profession to the concept of the control and mastery of disease, to an idea of life with health as an entirely feasible goal, the time of reaching the goal to be determined by the ability of the profession to handle experimental medicine.

Medical schools must now train physicians to carry out the ever-advancing methods of medical science and to increase the knowledge of the control of disease.

In my opinion the major factor in finding those who will undertake experimental research is the intellectual quality of the teacher. He must present his science with life, he must himself see medicine as a growing subject, with emphasis in his lectures and in discussions with students on new points of attack in places where new work is feasible so that it will be ideas that lead students toward research. It seems to me that the teacher should both suggest research to the student he deems especially fitted for the work and that he should be receptive and understanding toward the student who asks for research. I can not but feel that the leading of students toward research by charm of ideas must be more attractive to any teacher than any application of an "all or none theory" to research.

To select or accept the right students, to choose feasible problems, to direct students so as to retain their interest, to use all their originality, to smooth out their difficulties to some extent, yet not too much, let no one think this an easy task or a task in which any teacher no matter how much of the superman he may be may expect success in every case, but it is the most fascinating task of all teaching. The measure of its success is the measure of the progress of experimental medicine. Any plan of training research workers, whether involving all the students or a selected group, must be judged by the numbers actually trained in the experimental method. Anything less than this misses the point of our present needs.

Training in experimental science needs a degree of supervision that must necessarily limit the numbers for each teacher. The use of animals alone puts the need of supervision beyond argument and the methods of research are of ever-increasing complexity. By this I mean that even if the policy of an institution involves giving every student a problem, it will actually be only the few that get adequate training in an experimental problem. But of more importance than all these technical matters of supervision and of training in method is the attitude of the teacher himself. He may present his own theories which will often be the basis for the start of the student, but he must leave the student's mind free to judge the evidence for himself and free to differ with his instructor; under any other terms there is no liberty in education. No teacher has unlimited problems which he is capable of directing. His own work does not have unlimited new points of attack at any one time, but the new problems develop constantly as the work grows. Thus the taking of research students does not fit readily into a routine; each school is organized to take a stated number of new students into its classes each year, but the number of new research students a teacher can take depends on several variables such as the number of the older group that have finished their problems, the status of the teacher's own work, etc.

Any method which might involve an assignment of research students to a given teacher would in my judgment be most unfortunate. One of the most essential requirements for success is an intellecutal compatibility between student and teacher resting on the basis of free choice on both sides.

It is rare that a teacher can direct research that is far from the range of his own work either past or present, but this does not mean that every or even any students should be brought directly into the teacher's own problem, but it does mean that the teacher must be familiar with the ideas and the type of methods. A glance at any of the scientific journals of the day will show that medical research is tending markedly toward joint endeavor. This is inevitable because the complexity of experimental methods puts certain problems, and now an ever-increasing number of them entirely out of the scope of ability of a single worker. This is true in the use of a given technique and in problems that involve the techniques of two or more branches of the medical sciences, as, for example, the combinations of biological and chemical research. Such joint endeavor is of the utmost advantage to science and to trained investigators themselves. To bring a student just beginning research into joint research is, in my opinion, sometimes justified and feasible, but it must always be done with the utmost care and foresight lest the student become merely a technician and fail to get an adequate training.

The selection of a problem for a student needs nice judgment. It should be a task, in the first place, which is feasible. The trained investigator can often

afford to try out a problem that is purely speculative, but a student needs a more safe investment. Secondly, though the instructor is convinced that the problem can be solved, it must offer some chance for the student's own initiative, must give him some play of ideas; it should involve the preparation of specimens, of the performance of experiments which he can carry out himself so that he can be gaining the concept of the essentials of experimental science, which are the formulation of ideas, the development of plans to put them to the test, and then observation, records and analysis. Thirdly, an ideal problem for a student must open up a field for him for further work so that he will get the best thing out of research, a training in a concept of knowledge as a growing thing. With these points in mind, it will be evident that joint research between teacher and student has certain disadvantages for the student that can only be overcome provided the instructor is frank in discussion of its dangers and alive to the idea of giving the student a well-rounded training. The advantages to the student of solving a problem during his medical course are threefold. First, he receives valuable training and gains a new standard of work. Many times I have seen the quality of all the work of a student raised as the result of his training. Second, it enables the student to analyze his own abilities and tendencies from his actual experience. Third, it opens to him the door of opportunity in case he finds that he is actually interested in research and teaching.

From what I have said, it will be obvious that I should make each teacher entirely free in the matter of the training of students in research. This freedom would of course include taking no students, some or all. To make a place in a university for the work of a Willard Gibbs, whether he takes some students or none, whether his work is understood in his day or not, is the great reward of freedom in education. But from the standpoint of the development of medical science, I should judge a school that gave no opportunity for students to start in research as not carrying the full load of the modern university. With the question as to the most fruitful way of meeting the problem of introducing students into medical science, whether by starting every student with a problem and selecting the best or by trying to select those best suited to research and giving them more intensive training, I should let the results be the judge. But, in my opinion, it will not be the method that will be the decisive factor but the individual teacher; given a Ludwig, a Mall or a Welch on the faculty, the question of research will take care of itself. Find the teacher with the gift for stimulating students toward research and give him freedom; he will determine his own method.

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### DISCUSSION OF DR. SABIN'S PAPER

I HAVE had a rather unusual opportunity to see how such a plan as outlined by Dr. Sabin would work. For a number of years I taught classes in which were her research students, and there is no question but that the enthusiasm produced by their work with her was of great value to them and stimulating to the other students. Certainly there is a very great chance for the student to gain an experience and to develop a scientific critique which will be of value to him throughout the remainder of his life.

There is an obvious corollary to this discussion which might be mentioned and that is that there should be experienced and active investigators in all medical schools. I think it is not too optimistic to hope that each teacher of medical students will be an active investigator in the field in which he is teaching. I believe that a teacher not engaged in active investigation can not give the student what the student deserves.

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## RESEARCH IN LAW

IF one examines existing university law schools he will find that even the best of them have down to date been chiefly professional training schools for those who expect to practice at the bar. A few have arranged to give the members of their faculties a teaching load light enough to permit them to engage in research and writing. None have purported to do much in the way of training legal investigators, except in so far as they have claimed that the pursuit of the regular professional curriculum does so. It must be confessed that the notion that the curriculum does accomplish this purpose is widespread among law teachers, although, as will be pointed out later, nothing could be more unfounded. In addition, the work which students of high standing are expected to do in editing such periodicals as the Columbia and Harvard *Law Reviews* and the *Yale Law Journal* is supposed to give the privileged few who are chosen to the editorial board an adequate training in legal research.

To complete our survey of present conditions we need to add that in recent years a few of the schools —they can be counted almost on the fingers of one hand—have offered a year of graduate work in addition to the regular three-year law school course, and

in this year have permitted and encouraged, but not as a rule required, candidates for advanced law degrees to do what has been called "legal research."

If now we examine into what is meant by research we find that it consists almost entirely in a painstaking collection by the one doing the research of a large number of the decisions of the courts within the field under consideration, and the attempt to piece these together into some general propositions which are conceived to be a statement of the existing law.

Probably at this point it should be said for the benefit of those of my hearers who are not trained in the law that by far the larger part of our law is so-called "common law." Its rules and principles have been worked out through the centuries by the English and American judges, and are not derived from statutes passed by the legislative bodies. The accepted legal theory is that we in America inherited from the mother country—England—a body of "common law" which we have ever since been "applying" to new situations as they presented themselves for adjudication. In developing and applying these rules and principles the courts of the several states have each had a practically free hand, as the common law has in theory been adopted not by the federal government but by each state separately. It is common knowledge that there has thus arisen great diversity of view in the different states as to how given rules or principles apply to new situations, so that to-day, so far as the actual decisions go, the particular common law of New York differs in many important respects from that of, say Massachusetts or New Jersey. There is, so to speak, a strong family resemblance between the systems of rules and principles applied in each of the states, but differences of detail abound. This result, of course, is not surprising to those who understand the logical limitations of all those generalizations which we are in the habit of calling rules and principles.

The attempt of the legal investigator in America to reduce to a coherent system the confused mass of precedents gathered from nearly a half hundred independent jurisdictions, each with a court of last resort to decide what "the common law rule" applicable to each situation is, thus requires him to select from the conflicting views those decisions on a given point which he for some reason or other considers the better, or more sound. Consequently we find the legal investigator and writer not merely setting forth the rules and principles which he regards as "the law," but explaining why he has chosen one rather than another view. This he usually conceives himself able to do without going outside the legal system. That is, he assumes that he can select wisely merely by reasoning about the matter with nothing more to guide him than his knowledge of the cases (including of course the opinions of the courts in which they purport to set forth the reasons for their conclusions), supplemented by whatever slight knowledge of economics or other social sciences he may have chanced to pick up more or less fortuitously.

This method of conducting legal research is apparently based upon a belief that a technique of this kind is adequate for the purpose in view. When we recall that included in the process is a choice between conflicting rules of decision as laid down in the adjudications of a half hundred independent courts of last resort, each of which is entitled to have the last word as to the law within the limits of the state in which it is sitting, we are brought face to face with the question whether indeed this "traditional and known technique" of the common law—as Dean Roscoe Pound calls it—is adequate for the needs of to-day.

This question is the more important as it is at last beginning to dawn upon the more thoughtful members of the community that we are in a period of rather profound social and economic change. The development of new techniques of transportation and of the production and distribution of goods, with the consequent mobilization, so to speak, of the world's population, is producing great changes in the structure of the social order. Especially in America the bringing together of heterogeneous groups of people with widely varying behavior patterns is causing profound alterations in outlook, so that old rules of law adapted to an earlier and far simpler civilization are no longer functioning with efficiency. It is obvious that in such a period the changes in the social and economic order must be reflected in an increasing uncertainty in the legal rules, as, whether they will or no, the courts are bound to endeavor to adjust the legal system to the new situation.

If, then, as the present speaker believes, much of the uncertainty in the law of which we hear so much is the inevitable accompaniment of these social changes, it requires no demonstration to show that an attempt to evaluate existing rules of law, to say which line of conflicting decisions of the courts is the better and to outline the path along which new developments in law should proceed, must involve a knowledge of, or at least an honest attempt to find out, why our rules of law do not meet the needs of present-day society, and what changes in them would produce better results. Thus we are led to the conclusion that in order to do worth-while research in law the investigator of the present and the future must be equipped with an orderly and systematic understanding of the structure and functioning of the social and economic order, and can not depend upon

the hit-or-miss knowledge which he has chanced to pick up. He must realize that his own experience has been limited—to one spot on the earth's surface, to membership in one social or economic class, etc.—and that only a wide and searching study will equip him with the necessary insight into the meaning of the life of to-day.

It is unfortunately a fact that most lawyers and even most law teachers are to-day inadequately equipped in this respect, for the obvious reason that even if they are graduates of our better law schools no attempt was made in their school days to furnish the needed information or understanding or to enlist their interest in the task of acquiring it for themselves.

To-day in the law school world we are beginning to hear much of plans for legal research on the part of a very few of the leading law schools. So far only a little has been said about the necessity of training for the work of legal investigation men who will have not only an accurate knowledge of the legal rules but also an adequate foundation in scientific method and in the other social sciences. The law schools can not act on the supposition that adequate training in these other fields has been acquired in existing colleges before the students enter the law school. Observation for many years of college graduates entering law schools has shown that only a very small fraction of them—so small as to be negligible—can be expected to possess the type of training called for.

If then in the days to come worth-while, really scientific legal research is to be carried on, it seems clear that a new type of legal curriculum must be devised, in which prospective legal investigators will not merely study the rules of law and the old technique, but will also be given an adequate foundation both in other social sciences and in the technique of scientific investigation. The student beginning the study of law with the avowed purpose of fitting himself for research work should at the outset study the structure and functioning of the existing social and economic order. Also without doubt he should at the very beginning be brought face to face with the problems of methodology. How are words used in reasoning? How do judges and lawyers really think, as distinguished from the way they think they think? What tools are available for use in that thinking? How does scientific technique in the field of the social sciences differ, if indeed it does differ, from that in the so-called exact sciences? How does the technique of research in law differ from, let us say, that in economics? All these and other related problems should be raised at the start and answered, so far as that can be done, so that the student may bring the discussion to bear on all his other work. It is also quite possible—indeed I for one think it quite probable—that for the purposes of study the various rules of law should be entirely rearranged in new groupings. To-day in the regulation law school curriculum the arrangement of topics is according to the nature of the rules as legal institutions—contracts, torts, property, agency, etc.—without regard to the part they play in regulating human conduct. It would seem that if the legal rules are thought of—as they should be—as tools, devices which society uses to regulate and promote human conduct, and that if they are to be evaluated from the point of view of their efficiency in promoting ends which we deem proper or desirable, they should be studied from the outset in a way which would bring this out. Since this evaluation can be made only in terms of a thorough understanding of the ends sought to be attained and of the available means of attaining them, it seems obvious that the grouping of the legal rules for the purpose of study should be made from this point of view; that is, the rules should be grouped about the human relations which they regulate and promote, and not, as now, treated merely as legal institutions to be studied, so to speak, *in vacuo*.

The conclusion which we reach, therefore, is that the needs of the present situation can best be met by the devising of an entirely new type of legal curriculum, which will have in view the training of students so that they will possess the necessary scientific equipment for this new type of legal investigation, *viz.*, that of determining how the rules of law are actually working in promoting or retarding, as the case may be, the achievement of desired ends. Legal historians should be trained who would deal with legal history from the same point of view, relating the evolution of the law to the social and economic institutions of the times. If, as I venture to think, most legal history down to date has been of less value than had been hoped, it is because it has been not merely largely antiquarian, satisfying itself with determining the origin of legal rules without following them through their development, but also non-functional, *i.e.*, it has made no attempt to relate the rules to the ends sought to be attained by them.

Whether this new type of curriculum would also serve to train practicing lawyers is another question which can not be discussed upon the present occasion. In passing, however, I venture the confident prediction that it would be found that men trained in the manner suggested would not only practice law far more intelligently than most of the present-day lawyers, but would also be more useful members of the profession in that they would be equipped to render more valuable services in promoting needed legal re-

forms. Be this as it may, the present speaker is convinced that since really scientific legal investigation necessarily involves a study of the functioning of legal rules and principles in society, the traditional professional curriculum as it now exists in the law schools is not adequate for the training of the needed investigators. Indeed, one is justified in saying that the training in the traditional technique and nothing else, as now given in nearly all law schools, even though it follows a so-called liberal college education, is likely to destroy whatever fitness the student had for investigation of the kind demanded, for the reason that it tends to fix ways and modes of thinking which come down to us not merely from the middle ages but from the time of Aristotle; ways and modes which are as yet substantially untouched by the modern scientific outlook upon the world of thought.

There is thus a need that there shall be developed one or more university schools of what, for lack of a better term, we may call "jurisprudence," that is, legal science, with a curriculum avowedly adapted to the training of legal scientists as distinguished from practitioners of law. Above all, the students in such schools of jurisprudence should be given an insight into what a scientific approach to problems in any field is and what it involves, and so an appreciation of the difficulties to be overcome in applying scientific technique to the social sciences and especially to that of the law.

Underlying all that I have said will be found a postulate which has been tacitly assumed and not discussed, *viz.*, that a really scientific study of law, or as I prefer to say, legal phenomena, is possible. Into the justification for making this postulate I can not now go, although if time permitted cogent reasons could be urged for doing so. As it is, we shall have to content ourselves with saying that, unless we make it, all talk about research in law from a scientific standpoint is futile and a waste of time. That at the present moment a real science of law does not exist is obvious; but all that this signifies is that as yet no serious attempt has been made to apply a truly scientific approach to the study of legal problems. We are still in the era when professional philosophers who know almost nothing about law write books about the philosophy of law, just as earlier they wrote about natural philosophy and mental philosophy. These latter topics have now been turned over to the scientists who study physics and chemistry on the one hand and psychology on the other. If indeed the science of psychology is still in its earlier stages, it is because a completely scientific approach has not been achieved. At the present moment, however, psychology seems at last to be fairly on its way to the discovery of a sound scientific method of working. In like manner the dawn of a real science of law will doubtless be heralded by the disappearance of treatises upon the philosophy of law by professional philosophers who know little or no law, and the writing of such books by those who are not scientific experts in the field of legal phenomena will be as rare as the production of works upon the philosophy of medicine or of psychology by those not trained in those fields. Before this time comes, however, we must train a generation of legal scientists, sufficiently grounded in the broadest aspects of their field of study so that they can do worthily the work which the philosophers with inadequate legal training are endeavoring to do to-day. Such men will understand not only the possibilities of the technique they are using but also its limitations. When, and only when, we have a sufficient number of men trained in the manner suggested we shall have a genuine "philosophy" of law, using that term in its broadest sense, for then and only then will it be founded upon an adequate study of all the relevant phenomena by men trained in a sound scientific technique.

Walter Wheeler Cook
The Johns Hopkins University

(*Concluded in next issue*)

## COSMIC ASPECTS OF ATMOSPHERIC ELECTRICITY[1]

There being as yet no generally accepted theory to account for the origin and maintenance of the earth's negative charge, it is of paramount importance to continue observation and investigation of the laws and modus operandi of the changes to which atmospheric electricity is subject during the day, year, and from year to year. The present paper is confined to a statement of facts applying to the so-called electrically or meteorologically undisturbed days, *i.e.*, to "fine-weather days," or days of no negative potential and no pronounced disturbances. It is only for these days that it has been possible up to the present to deduce world-wide laws. These facts in their generality have received further confirmation since the chief theories regarding the earth's electric charge were proposed.

In one notable respect atmospheric electricity differs from the equally elusive subject, terrestrial magnetism, in that the fluctuations of the atmospheric-electric elements are of the same order of magnitude as the absolute elements themselves—not fractions of a per cent. as is usually the case with the fluctuations of the magnetic elements. Thus, even on an electrically undisturbed day, the potential gradient may

[1] Presented at the Philadelphia meeting of the American Physical Society, December 29, 1926.

change from minimum to maximum during the day, or during the year, by a quantity approaching and even equalling its mean daily or annual value, which normally is about 130 volts per meter.

Among the most striking facts is the one which my colleague, Dr. S. J. Mauchly, first found on the basis of the observations made on the various cruises of the *Carnegie*. A discussion of these observations enabled him to announce[2] at the Washington meeting of the American Physical Society in April, 1921, "that the chief component of the *diurnal variation of the potential gradient* over the major portion of the earth (especially the oceans) is a 'wave' of 24-hour period which occurs simultaneously in all localities." Susbsequent investigations[3] by Dr. Mauchly, which included also observations at land stations, led to a general confirmation of this conclusion.

Dr. Karl Hoffmann, evidently unaware of Dr. Mauchly's communication of 1921, announced[4] in 1923 that the daily extreme values of the potential gradient at Arctic and Antarctic stations, as shown by the available series, occur everywhere at about the same absolute time.

Recent observations in Arctic regions and elsewhere have confirmed in the main the validity of the conclusions by Mauchly and Hoffmann. We have now available for this purpose a series of potential-gradient observations made by the Department of Terrestrial Magnetism in cooperation with the MacMillan Expeditions to Baffin Land, 1921–22, and the Northwest Coast of Greenland, 1923–1924, also at the two observatories of the department, one in Western Australia and the other in Peru. Furthermore, a valuable series of observations was obtained in cooperation with the department by Captain Amundsen's *Maud* expedition, 1923–1925. Dr. H. U. Sverdrup, in charge of the scientific work of the expedition, from a discussion of all available observations on meteorologically undisturbed days reached the following conclusion: "Our observations in the Arctic Sea, far from land or close to the coast near the 160th meridian of east longitude, give very positive confirmation of the conclusions by Mauchly and Hoffmann."

While Dr. Mauchly was investigating the *Carnegie* observations, referred to above, the writer suggested[5] to him that the observed diurnal variation of the atmospheric potential-gradient on a universal-time basis may find an explanation in its association with the asymmetry of the earth's magnetic field with reference to the earth's axis of rotation. It may be significant that, on the average, when the potential gradient reaches its principal maximum value the sun is near the meridian of the north magnetic pole and that when the gradient reaches its principal minimum value the sun is near the meridian of the south magnetic pole.

There are land stations, which, evidently because of local influences of one kind or another, show extreme values of the potential gradient at times differing an hour or more from the average times, and there are some land stations which exhibit double maxima and minima in the diurnal variation of the potential gradient. It is generally found at these latter stations that one of the maxima and one of the minima values occur near the average times of extremes of the potential gradient in undisturbed regions. Suffice it to say that all available data on hand at present show that if the hourly values of the atmospheric potential-gradient be plotted according to universal time there will be found a general agreement in phase among the curves for stations in very remote regions, such as is not exhibited if the hourly values be plotted according to local time.

It certainly must be regarded as an impressive and significant fact that the potential gradient of atmospheric electricity passes nearly everywhere through extreme values during twenty-four hours at about the same universal times, irrespective of whether the observing station be enveloped by sunshine or by darkness. When the potential gradient reaches its minimum, the value may only be about 20 per cent. of the mean daily value.

Turning next to the *annual variation of the potential gradient*, we encounter another fact of cosmic interest, namely, that generally from the Arctic to the Antarctic the maximum occurs during the six-month period, October to March, when the earth's distance from the sun is less than the mean distance for the year, and that generally the gradient reaches its minimum value during the six-month period, April to September, when the distance between the earth and sun is greater than the mean distance. Several investigators have previously drawn the conclusion from land observations, especially in the polar regions,

[2] *Physical Review*, new series, Vol. 18 (1921), pp. 162 and 477.

[3] See *Terrestrial Magnetism and Atmospheric Electricity*, Vol. 28 (1923), pp. 61–81, and particularly *Researches of Department of Terrestrial Magnetism*, Vol. V, Washington, 1926, pp. 387–402.

[4] *Beiträge zur Physik der Freien Atmosphäre*, XI Band, Heft 1, 1923.

[5] See S. J. Mauchly's report presented at the meeting of the American Geophysical Union, April 18, 1921, *Bulletin of the National Research Council*, No. 17, p. 77, Washington, D. C., 1922.

that the extreme values of the potential gradient occur at about the same time of the year, hence not at the same season everywhere. The writer in addition has found from a discussion of the *Carnegie* ocean observations, and recent land stations, that nearly everywhere the mean value of the potential gradient for the six months October to March, when the earth is nearest to the sun, is greater than the mean value for the six months April to September, when the earth is farthest from the sun.[6] Accordingly, distance of the earth from the sun, rather than season, appears to be the controlling factor.

If we confine our attention to series of observations since 1900, when more rigorous methods of observing were employed than formerly, two outstanding exceptions from the general rule just stated are found, namely, the observations at Helwan, Egypt, 1907–1914, and those made by Dr. G. Berndt at Buenos Aires, 1911–1912. Dr. Wait, of the Department of Terrestrial Magnetism, has carefully investigated the Helwan series and he has been led to infer that this station may be subject to disturbing influence, owing to the seasonal variation in sand storms. The results at Buenos Aires depend on electrometer readings made three times daily for one year from May, 1911, to April, 1912. It would be highly desirable that additional observations be obtained at these two stations and that the annual variation be derived on the basis of both electrically undisturbed and disturbed days.

On the average, from the Arctic to the Antarctic, the monthly mean values of the potential gradient vary during the year from minimum to maximum to the extent of about 60 per cent. of mean gradient for the year.

Another interesting fact is that the *daily range of the potential gradient* varies during the year, generally in the same manner as has been stated with regard to the gradient itself. In other words, the daily range is a quantity very similar to the potential gradient; the former may be looked upon as counted from the minimum value as the zero, whereas in the case of the usual potential gradient the earth is assumed at zero potential.

And now we come to the consideration of the question of a possible *relationship between changes in the annual values of the potential gradient and changes in solar activity during the 11-year cycle.* In a paper published in 1924,[7] I brought together all the available data through 1923. The chief conclusion was that "the probability is high that the atmospheric potential-gradient and its diurnal and annual ranges, as also the air-earth current, are subject to sunspot influence." For an average increase of 90 in the sunspot number, between minimum and maximum sunspottedness, the increases in the potential gradient and its diurnal and annual ranges were found to be about 30 per cent.

With the aid of fifty-nine series of diurnal-variation observations of the potential gradient made aboard the *Carnegie* in the different oceans during 1915-1921, including the year 1917, of maximum sunspot activity, I again investigated the matter in 1925,[8] reaching once more the conclusion already stated. Dr. Mauchly could not find any adequate cause for the observed changes in the potential gradient, other than the one already mentioned of possible effect arising from varying sunspottedness.

It will probably be necessary to await the completion of another cycle and the accumulation of data at widely distributed stations, not subject to local disturbing influence, before all the questions arising as to the precise nature of any solar-activity influence on atmospheric electricity may be definitely settled. However, renewed interest has been aroused in the problem and it is also gratifying in this connection that beginning in 1928 the observational work in atmospheric electricity aboard the *Carnegie* will be resumed.

Owing to the meagerness of available data, it is not possible at present to state whether, or not, the *electric conductivity* of the atmosphere is subject to cosmic influences.

It will be a long time before the question as to any possible *secular changes* in the atmospheric potential-gradient can be investigated successfully. For example, do the mean values of this gradient for a solar cycle vary from cycle to cycle, as does mean sunspottedness?

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[6] *Researches of Department of Terrestrial Magnetism and Atmospheric Electricity,* Vol. V, Washington, 1926, pp. 382–384.

[7] *Terrestrial Magnetism and Atmospheric Electricity,* Vol. 29 (1924), pp. 23 to 32 and 161 to 186.

[8] See *Researches of Department of Terrestrial Magnetism and Atmospheric Electricity,* Vol. V, Washington, 1926, pp. 361–381.

## AWARD OF FELLOWSHIPS BY THE GUGGENHEIM MEMORIAL FOUNDATION

THE award of fellowships totaling $143,000 to sixty-three scholars, writers, musicians and artists has been announced by the trustees of the John Simon Guggenheim Memorial Foundation. Seven of the awards were to enable completion of work undertaken

fellows appointed last year. The awards, given annually, are made possible by the gift in 1925 of $3,000,000 by former United States Senator Simon Guggenheim and Mrs. Guggenheim in memory of a son who died in 1922.

The committee that made the awards comprised President Frank Aydelotte, of Swarthmore College, *chairman;* President Ada Louise Comstock, of Radcliffe College; President Frederick C. Ferry, of Hamilton College; Professor Charles Homer Haskins, of Harvard University, and Dean Charles B. Lipman, of the University of California.

The list of awards in the field of science, as announced by the foundation, follows:

Dr. Edward Frederick Adolph, assistant professor of physiology, School of Medicine and Dentistry, University of Rochester, to study the internal factors that control the size of organisms, particularly during growth, principally at the Kaiser Wilhelm Institute, Berlin.

Dr. William Ruthrauff Amberson, assistant professor of physiology, School of Medicine, University of Pennsylvania, to study mechanisms involved in the electrical stimulation of nerve and muscle, principally with Dr. A. V. Hill, at University College, London.

Dr. Richard Bradfield, associate professor of soils, University of Missouri, to investigate the principles involved in the purification of colloids by electro-dialysis, principally with Dr. Herbert Freundlich at the Kaiser Wilhelm Institute, Berlin.

Dr. Ralph Erskine Cleland, associate professor of biology, Goucher College; for studies of the chromosome constitution and behavior of the evening primroses (oenothera), as related to certain genetical problems, in consultation with European authorities.

Dr. Carl Henry Eckert, National Research fellow, California Institute of Technology, for researches concerned with the new quantum theory, with Professor A. Sommerfeld at Munich, and E. Schrodinger, at Zurich.

Dr. William Henry Eyster, professor of botany, University of Maine, for a study of the physiology of the chloroplastic pigments—principally with Professor Richard Willstätter, Munich.

Dr. Philip Franklin, assistant professor of mathematics, Massachusetts Institute of Technology, to study integral equations, orthogonal functions and their relation to almost periodic functions, principally at Göttingen, Germany, and Zurich.

Dr. George Ernest Gibson, associate professor of physical chemistry, University of California, for research in the field of the theory of band spectra, principally at the University of Göttingen, Germany.

Dr. Rodney Beecher Harvey, associate professor of botany, University of Minnesota, to investigate low temperature effects on plants, principally at Cambridge University. Dr. Harvey has discovered that ethylene gas will hasten the ripening of fruits and vegetables. By injecting less than 40 cents' worth of gas into a carload of green bananas they can be ripened within forty-eight hours.

Dr. Lewis Victor Heilbrunn, assistant professor of zoology, University of Michigan, for researches into the colloid chemistry of protoplasm, principally with Dr. Herbert Freundlich, at the Kaiser Wilhelm Institute, Berlin.

Dr. William Vermillion Houston, National Research fellow in physics, California Institute of Technology, to study the most recent developments in quantum mechanics as applied to the explanation of spectra, principally with Professors A. Sommerfeld, at Munich, and Niels Bohr and A. Heissenberg, at Copenhagen.

Dr. Frank C. Hoyt, research associate, University of Chicago, for research into the quantum theory and its meaning for radiation and atomic structure—at Göttingen, Copenhagen and Zurich.

Dr. Victor F. Lenzen, assistant professor of physics, University of California, for a critical study of statistical mechanics at Göttingen and Zurich.

Dr. Edwin Blake Payson, professor of botany, University of Wyoming, for studies in taxonomy in relation to generic phylogenies, principally at Kew Gardens, London.

Dr. Lloyd Hilton Reyerson, associate professor of chemistry, University of Minnesota, for investigations in the field of contact catalysis, principally with Professor Herbert Freundlich at the Kaiser Wilhelm Institute, Berlin.

Dr. Manuel Sandoval Vallarta, assistant professor of physics, Massachusetts Institute of Technology, to study the connection between Schrodinger's wave mechanics and the Einstein theory of relativity, in consultation with European authorities.

Harry Schultz Vandiver, associate professor of pure mathematics, University of Texas, for research abroad on Fermat's last theorem and the laws of reciprocity in the theory of algebraic numbers.

Dr. J. Walter Woodrow, professor of physics, Iowa State College, to study the phosphorescent, chemiluminescent and photoelectric properties of cod liver oil and other substances which either have anti-rachitic characteristics or can be activated by treatment with ultraviolet light, principally with Professor E. Rutherford, of Cambridge University, and Professor J. S. E. Townsend, of Oxford University.

Renewal of grants to the following fellows of the foundation, appointed last year, were announced among others as follows:

Dr. Wallace Reed Brode, Bureau of Standards, Washington, D. C., to continue abroad research on the absorption spectra of simple azo dyes.

Dr. J. Penrose Harland, University of Cincinnati, to continue investigations in the Bronze Age civilizations of the Aegean Basin.

Dr. Linus Carl Pauling, California Institute of Technology, to continue theoretical and experimental researches on the atom.

# SCIENTIFIC EVENTS

## SIR ISAAC NEWTON'S BI-CENTENARY

THE History of Science Society, in collaboration with committees from The American Mathematical Society, Mathematical Association of America, American Astronomical Society and the American Physical Society, proposes to commemorate the 200th anniversary of the death of Sir Isaac Newton by an appropriate program at Columbia University, New York, November 25 and 26, 1927.

On this occasion it is planned to have addresses relating to the great contributions of Newton to the advancement of mathematics, astronomy and physics, and setting forth his interests in chemistry, chronology, theology and other branches of learning. It is also hoped that some reference will be made to Newton's early contribution to the advancement of science in the American Colonies—when Harvard and Yale Colleges were in their infancy. Each subject will be represented by at least two papers given by scholars of distinction.

It is proposed to have a large exhibition of Newtoniana, including the first edition of the Principia, and other related publications, also portraits, medals and autographed letters and documents, and such material as bears directly upon his life, achievements and contemporaries. Therefore it is hoped that those who have material of this nature will take pleasure in loaning it to the committee in charge of the exhibit; it is requested that those who can contribute will communicate as soon as possible with the secretary.

Similar commemorative programs have already been held on the anniversary date of Newton's death, namely, March 20, by various societies and universities of this country, and also in England. The History of Science Society will take the opportunity to honor Newton, at its regular annual meeting.

A full program of papers and speakers with other particulars will be published in SCIENCE during October.

The following individuals form the Program Committee:

For the History of Science Society—
Dr. David Eugene Smith (*chairman*), Columbia University.
Dr. Henry Crew, Northwestern University.

For the American Mathematical Society, and Mathematical Association of America—
Dr. R. C. Archibald, Brown University.
Dr. E. W. Brown, Yale University.
Dr. Florian Cajori, University of California.

For the American Astronomical Society—
Dr. E. W. Brown, Yale University.

For the American Physical Society—
Dr. Leigh Page.

FREDERICK E. BRASCH,
*Secretary of the Committee*
LIBRARY OF CONGRESS,
WASHINGTON, D. C.

## THE CENTENARY OF THE BIRTH OF LORD LISTER

THE centenary of the birth of Lord Lister, the pioneer in antiseptic surgery, occurs on April 5. The occasion is being widely celebrated in England. On April 4, the day before the reception in the great Hall of the British Medical Association of the official delegates to the Lister centenary, Sir St. Clair Thomson will give an address at the social evening of the Royal Society of Medicine on "The Centenary of Lister—Recollections by One of his House-surgeons."

The Lister memorial committee of the Canadian Medical Association aims to establish the fifth of April as Lister Day in medical schools, hospitals and health centers throughout the world.

A public meeting in celebration of Lord Lister's centenary is to be held in the McEwan Hall, Edinburgh, on Wednesday, July 20, at 8 p. m. The Right Honorable the Earl of Balfour has consented to take the chair, and short addresses will be delivered by Sir William Watson Cheyne, Bt., Professor Tuffier, of Paris; Professor Harvey Cushing, of Harvard University, and Dr. James Stewart, of Halifax, Nova Scotia.

The *British Medical Journal* states that throughout the week of the annual meeting of the British Medical Association a museum of Lister relics will be on view in the upper library of the old university. In this connection most generous assistance has been given by the director of the Wellcome Historical Medical Museum, London, and his staff, and the unique interest of the exhibits will largely be due to their cooperation.

A Lister memorial volume has been prepared, and with the consent of the council of the British Medical Association it will constitute the book of the meeting in so far as a copy will be presented to each member of the association who registers. The volume, edited by Dr. Logan Turner, contains a variety of contributions; a sketch of Lord Lister's life is given by his former house-surgeon, Sir George Beatson, of Glasgow. A series of short personal reminiscences has been written by Sir William Watson Cheyne, Dr. Rutherford Morison, Dr. Grasett, Dr. Baldwin, Dr. T. R. Ronaldson, the late Professor Francis Caird, Dr. Stewart (Halifax), Dr. Douglas (Cupar) and Mr. Hamilton Russell, of Melbourne. Two of Lister's scientific addresses and a series of letters of general interest are incorporated in the book. A number of

striking comments which he made at various times in relation to the germ theory and the antiseptic system, and, in fact, upon things in general, have been grouped in a chapter under the heading "Obiter dicta." A section of particular interest is that dealing with the lives of Lister's fellow residents in the Edinburgh Royal Infirmary during the summer of 1854, a group which included Beddoe, Christison and Kirk—men who won distinction in widely differing fields. This chapter has been contributed by Dr. Logan Turner. A chapter entitled "Surgery Prior to Lister's Time" is written by Mr. Alexander Miles, while an article on the influence of Lister's work on surgery is contributed by Professor Fraser; Professor Sharpey-Schafer deals with Lister's work as a physiologist. The volume, which will contain from 180 to 200 pages quarto, is illustrated, and, except in so far as reproduction of certain letters and published articles is concerned, the matter is original.

The residences which Lister occupied while in Edinburgh have hitherto been undistinguished by any memorial inscription. The committee considered the present a suitable opportunity to remedy what may have seemed to many an omission. With the generous consent of the proprietors concerned, short indicatory inscriptions are being placed upon the wall of 11, Rutland Street, and 9, Charlotte Square.

A donation of £25 was received by the committee, the donor desiring that this sum should be awarded as a prize for the best essay submitted on the subject "The Influence of Lister on Surgery." To the original prize the committee has added a gold medal, and this award is open to students and graduates of not more than one year's standing of any medical school in the British Empire. It is intended that the award of the prize and medal shall be made by Lord Balfour at the Lister centenary meeting on July 20.

## YALE-IN-CHINA

THE trustees of Yale-in-China have issued a statement announcing the resignation of President Edward H. Hume, to take effect in July. They report:

The trustees and Dr. Hume have long felt that executive control of the colleges at Changsha should pass into Chinese hands as early as possible. With this thought in mind every encouragement was given to the creation of a Chinese board of managers for the Medical College, the new board taking complete control in the spring of 1925, when Dr. F. C. Yen, a distinguished Chinese medical graduate of Yale University, became principal.

In order to make Chinese leadership effective in the College of Arts and Sciences as well, a policy in which the trustees and Dr. Hume are fully in accord, the resignation of President Hume was offered to the board of trustees on June 24, 1926, and was accepted in October. Negotiations for a Chinese successor were in progress, and it was hoped that announcement of an election could be made at the same time as that of Dr. Hume's resignation. The unfortunate events of the past few months have interrupted these efforts, but it is hoped to renew them as soon as practicable.

President Hume was called from a post with the United States Public Health Service in Bombay to lay the foundations of the medical work at Changsha in 1905. Until 1910 he was the only medical member of the staff, being joined in the latter year by Dr. F. C. Yen.

On October 18, 1915, the corner-stone of the new hospital at Yale-in-China was laid by Professor William H. Welch, of the Johns Hopkins Medical School, the building being opened to patients in February, 1918. Dr. Hume continued as dean of the Medical College and professor of medicine from 1914 to 1923, when he was elected president of the colleges of Yale-in-China.

In accepting President Hume's resignation, the trustees placed on record their appreciation of his conspicuous service during the past twenty-two years, in a special resolution:

Dr. Hume was among the first to put into effect a policy of partnership with the Chinese in medical education. Through his efforts he has been instrumental in developing one of the outstanding medical schools in the Far East. With a remarkable knowledge of the Chinese language and eloquence in using it, he has won for Yale-in-China many needed friendships. His Christian character, his strong faith, and ceaseless activity have kindled the enthusiasm of his colleagues and other workers throughout China.

## ORGANIZATION OF A LOUISIANA ACADEMY OF SCIENCES

A LOUISIANA Academy of Sciences was recently organized by Dr. I. Maizlish, head of the physics department at Centenary College, Shreveport, La. The object of the organization is to unite the scientists of the state, to foster scientific development and to encourage scientific research. The organization meeting was held conjointly with that of the Louisiana-Mississippi Section of the Mathematical Association of America at Centenary College, March 5, 1927. Those attending the meeting were very enthusiastic about the academy.

The officers elected are as follows:

*President:* Dr. I. Maizlish, Centenary College, Shreveport, La.

*Vice-President:* Dr. H. L. Smith, Louisiana State University, Baton Rouge, La.

*Secretary:* Professor Geo. Williamson, Louisiana State Normal College, Natchitoches, La.

*Treasurer:* Mr. F. M. Witherspoon, care of Louisiana Oil Refining Corporation, Shreveport, La.

*Members of the Executive Council:* Dr. H. V. Howe, Louisiana State University; Professor S. T. Sanders, Louisiana State University; Dean C. C. Bass, Tulane University; Professor H. E. Buchanan, Tulane University; Professor G. C. Hilman, Louisiana Polytechnic Institute; Professor A. C. Maddox, Louisiana State Normal College; Professor A. M. Alvarado, Loyola University; Professor Geo. M. Reynolds, Centenary College; Dr. Hubert G. Shaw, Louisiana College; Professor D. J. McNaspy, Southwestern Louisiana Institute; Mr. W. C. Spooner, Shreveport, La.; Mr. C. D. Evans, Shreveport, La.; Mr. Chas. Shutts, Lake Charles, La.; Dr. A. A. Herold, Shreveport, La.; Mr. F. J. Mechlin, Shreveport, La.

*Membership Committee:* President A. B. Dinwiddie, Tulane University; Dr. D. V. Guthrie, Louisiana State University; Dean Jno. A. Hardin, Centenary College.

## SCHOOL OF FORESTRY AT THE UNIVERSITY OF MICHIGAN

THE 1927 State Legislature is to be asked to appropriate sufficient funds to establish a separate school of forestry at the University of Michigan, and if this is granted, Samuel T. Dana, director of Northeastern Forest Experiment Station, will be appointed dean. In making this announcement, Dr. Little made the following statements:

It is high time that the University of Michigan should assume its proper rôle in the program of work in conservation which the state is to undertake. The university always has attempted to do its share in this matter but now feels, as never before, the very great importance of placing all such work on a very much more firm and extensive basis than it has hitherto occupied.

The conservation, reproduction and economic utilization of forests for industrial, recreational and educational purposes is one of the cornerstones of a permanent program of constructive general conservation and economy for the state.

It is believed that the state rightly will demand and provide the opportunity for leadership in this field from its university. Conservation of natural resources will insure adequate raw products to stabilize economic conditions, investigation of the problems of tree reproduction both under controlled and under natural conditions, the reforestation of waste areas by planting the proper development of the forest with its wild life as recreational factors in a highly industrialized state, and the utilization of the forests as sites for summer camp and educational work, are all of them phases of conservation in which the university can and should serve the state. Research work and the training of leaders in these fields will be necessary. The utilization of wood and wood products should be made the object of further investigation and of instruction.

To do this the university hopes next September to be able to establish as one of its branches a new school with S. T. Dana, now director of the Northeastern Forest Experiment Station, as its head. Mr. Dana is splendidly qualified as a scholar and executive to take charge of this work. He believes in service to the state and it is fair to assume that with adequate financial support the school, under his guidance, will set a standard for the state and I most earnestly hope for the country as a whole.

## SCIENTIFIC NOTES AND NEWS

WILLIAM HEALEY DALL, paleontologist of the U. S. Geological Survey since 1885 and honorary curator of the Division of Mollusks of the U. S. National Museum since 1869, died in Washington on March 27, aged eighty-two years.

PROFESSOR CHARLES SPRAGUE SARGENT, director of the Arnold Arboretum of Harvard University since 1872 and professor of arboriculture since 1879, has died on March 22 at the age of eighty-six years.

DR. WILLIAM H. WELCH, who resigned his position as director of the School of Hygiene and Public Health at the Johns Hopkins University to accept the chair of history of medicine, established last November by the General Education Board, will be in charge of a new library of medical history. This library, which is to contain 400,000 volumes, is being equipped with the aid of $750,000 received by the university from the General Education Board.

PROFESSOR JULIAN LOWELL COOLIDGE, of the division of mathematics of Harvard University, has been appointed exchange professor to France. He will lecture on algebraic plane curves and conduct a seminar in the Sorbonne.

PROFESSOR VICTOR C. VAUGHAN, of the University of Michigan, has been chosen by a committee representing the Medical Corps of the Army, Navy, Public Health Service and the American Public Health Association as the lecturer of the Kober Foundation at Georgetown University, and delivered a lecture on "The Chemistry of Living Substances and its Adaptability to its Environment," on March 28.

DR. LIBERTY HYDE BAILEY, retiring president of the American Association for the Advancement of Science, has been awarded the George Robert White medal of honor for 1927 by the Massachusetts Horticultural Society in acknowledgment of his achievements in horticulture.

DR. HUBERT WORK, secretary of the interior, was the principal speaker at the charter day exercises of the University of California on March 23. Dr. Work was accompanied by Dr. Elwood Mead, head of the United States reclamation service. They plan to go from San Francisco to Honolulu to attend the Pan-American Congress.

J. S. E. TOWNSEND, professor of physics at Oxford University, has been elected a member of the French Academy of Sciences.

THE University of Manchester will confer on May 18 the degree of doctor of science on Dr. C. S. Myers, director of the National Institute of Industrial Psychology, and on Professor R. Willstätter, now visiting the United States, formerly head of the department of chemistry at Munich.

MEMBERSHIP in the French Legion of Honor has been conferred upon Dr. William Henry Potter, professor of operative dentistry at the Harvard Dental School. The decoration was given in recognition of Dr. Potter's services during the war.

DR. GO YOH, a native of Formosa, was recently given the honor of Igakuhakushi, which is the highest distinction that can be bestowed on a doctor of medicine by Japan. According to the *Journal* of the American Medical Association, the honor is bestowed on one who has been instrumental in advancing scientific knowledge. Dr. Go Yoh is twenty-seven years of age and has been engaged in investigations in pharmacology.

PROFESSOR D. A. GILCHRIST, professor of agriculture at Armstrong College (University of Durham), Newcastle-on-Tyne, and director of the Northumberland Agricultural Experiment Station at Cockle Park, having reached the age limit, has resigned.

EDWIN H. BRYAN, Jr., instructor of entomology in the University of Hawaii, has been appointed curator of collections of the Bernice P. Bishop Museum, Honolulu, a position formerly held by Dr. Stanley C. Ball, who is now connected with the Peabody Museum at Yale University.

DR. ERICH W. SCHWARTZE, associate pharmacologist in the U. S. Bureau of Chemistry, has been appointed to the senior incumbency of the multiple industrial fellowship on cooking utensils at the Mellon Institute of Industrial Research, University of Pittsburgh. This fellowship was recently established for the purpose of making a comprehensive chemical and pharmacologicdynamic study of the effects of the corrosion of metallic cooking utensils during the preparation of foods.

DR. RICHARD G. BRODRICK, president of the American Hospital Association and former San Francisco health officer, has been appointed superintendent of the Stanford University hospitals and professor of hospital administration in the Stanford Medical School, effective on April 1.

DR. ROBERT H. LOMBARD resigned from the Geophysical Laboratory on March 1 to join the research laboratory of the Norton Company, manufacturers of grinding wheels and refractory products, at Worcester, Mass.

DR. ALEXANDER WETMORE, assistant secretary of the Smithsonian Institution, sailed on March 22 for Haiti and Santo Domingo, where he will spend the next three months studying and making collections of the bird life of the island.

DR. L. F. HAWLEY, of the staff of the Forest Products Laboratory at Madison, Wis., is visiting the forests of the West and Northwest in the interest of a chemical study of combustion in forest fires which may be undertaken at the laboratory.

DR. W. LAWRENCE BALLS has been appointed director of the botanical section of the Egyptian Ministry of Agriculture. At present Dr. Balls is paying a short preliminary visit to Egypt, at the invitation of the Royal Agricultural Society, to advise that body on a proposed cotton research institute.

O. W. TORRESON sailed from New York for Peru on February 17 to relieve R. H. Goddard, who has been in charge of the Huancayo Magnetic Observatory there for two years.

DR. W. R. CROWELL, assistant professor of chemistry at the University of California at Los Angeles, will be absent on sabbatical leave during the spring semester of 1927. Dr. Crowell will carry out investigations with Professor A. A. Noyes at the California Institute of Technology.

DR. STANISLAW MINKIEWICZ, of the Institute for Agricultural Research, Poland, is spending a year in the United States as a traveling fellow in entomology.

DR. CHARLES SCHUCHERT, professor emeritus of paleontology at Yale University and of historical geology at the Sheffield Scientific School, visited the University of California recently, gathering material for a new publication he is planning. While at Berkeley he spoke before the Le Conte Geological Club at a dinner given in his honor.

UNDER the auspices of the departments of physics and chemistry of Columbia University, Professor J. N. Brönsted, of the Royal Polytechnic Institute, Copenhagen, lectured on "Nitramid Catalysis" and "Acid Base Catalysis" on March 14 and 16, respectively.

DR. N. L. BOWEN, petrologist of the Carnegie Geophysical Laboratory in Washington, delivered a series of seven lectures in March before the geology club of Princeton University on the "Origin of Igneous Rocks through Fractional Crystallization"; and one before the combined clubs of geology and chemistry on "The Chemical Studies of the Geophysical Laboratory—their Geologic and Technologic Significance."

DR. ALPHONSE R. DOCHEZ, professor of medicine in the Columbia University College of Physicians and Surgeons, gave a De Lamar lecture at the Johns Hopkins University School of Hygiene and Public Health on February 21 on "Preparation and Use of Scarlatinal Streptococcus Antitoxin."

PROFESSOR A. V. HILL, Foulerton professor of physiology at University College, London, addressed the scientific staff of the Rockefeller Institute for Medical Research, New York, on March 25 on "The Viscous-elastic Properties of Muscles and their Molecular Basis."

DR. GEORGE H. DE THIERRY, professor of harbor and canal engineering and hydraulics at the Technical University of Charlottenburg, is on his way to this country to deliver a series of lectures at the Massachusetts Institute of Technology. The first of the lectures, which are to be given under the auspices of the department of civil engineering, will be on April 7.

FIVE addresses, spread over the period February–June, have been arranged as part of the centenary celebrations of University College, London. The speakers include Professor E. H. Starling, on "A Century of Physiology" on February 28, and Sir Oliver Lodge, on March 14, on "A Century's Progress in Physics."

DR. C. GORDON DOUGLAS, of Oxford University, will give the Oliver-Sharpey lectures, on the coordination of the respiration and circulation with variations in bodily activity, on May 3 and 5.

THE University of Leeds has accepted an offer by Dr. L. R. Braithwaite, surgeon to the Leeds Infirmary, to present to the Medical School a bronze bust of Sir Berkeley Moynihan.

ACCORDING to the *Journal* of the American Medical Association, Guy's Hospital, London, will celebrate the centenary of the publication of Bright's Reports of Medical Cases in July. Richard Bright settled in London in 1820 and was associated with Guy's Hospital from that year until 1843 when, resigning, he was made consulting physician. Invitations to be present at the celebration have been accepted by distinguished persons from all parts of the world, and the Royal College of Physicians of London will give a conversazione.

DR. CHARLES E. MARSHALL, since 1912 director of the graduate school and professor of microbiology at the Massachusetts Agricultural College, died on March 20, at the age of sixty years.

DR. CHARLES A. BRACKETT, for forty-seven years professor of dental pathology at the Harvard Dental School, died on March 19, aged seventy-seven years.

WILLIAM S. CHERRY, African explorer, was drowned on March 23, when he fell overboard from a steamship off the coast of Mexico during a storm.

M. DANIEL BERTHELOT, professor of physics at the University of Paris, recently died at the age of sixty-two years.

A MEMORIAL tablet to the late Sir Patrick Manson was unveiled by the British Minister of Health, on March 15, at the Royal Albert Dock Hospital. The tablet was erected by the Seaman's Hospital Society to commemorate the great services of Sir Patrick Manson to that society as well as to the cause of science. Sir Patrick was elected physician to the society in 1892, and labored almost continuously in its service for twenty years until he retired in 1912.

THOMAS A. EDISON will be honorary chairman and Maurice A. Oudin, vice-president of the International General Electric Company, chairman, of a committee which has been formed by Italian-American and electrical interests to represent America at exercises commemorative of the death of Alessandro Volta, on March 5, 1827. As previously recorded here, the exercises will be held at Como, Italy, Volta's native city, in June, when exhibits from all over the world will be shown. "Representing interests which owe a debt to Volta, we think it appropriate that Americans should create some memorial to him," the committee in charge said in a formal statement. "It is proposed that this memorial should take the form of an annual fellowship to an Italian electrical engineer, enabling him to spend one year in the United States in study and research. It is hoped that the announcement of the establishment of the fellowship may be made at the June meeting in Como."

THE anti-evolution bill in California was given a hearing before the committee on education on March 15. Each side was allowed ninety minutes to present its arguments. The committee voted unanimously to table the bill. That kills the anti-evolution effort in California for the present.

THE fourteenth annual meeting of the Federation of American Societies of Experimental Biology, which includes the American Physiological Society, the American Biochemical Society, the Society of Pharmacology and Experimental Therapeutics and the Society of Experimental Pathology, will be held at the University of Rochester School of Medicine, Rochester, New York, on Thursday, Friday and Saturday, April 14, 15 and 16. At the same time meetings will be held by the American Association of Pathologists and Bacteriologists, the American Association of Immunologists, the American Association for Cancer Research and the International Association of Medical Mu-

seums. The local committee consists of J. R. Murlin, *chairman,* W. R. Bloor, T. N. Devan, W. O. Fenn, S. Bayne-Jones, H. P. Smith and W. M. Sperry. W. O. Fenn is chairman of the sub-committee on demonstrations. S. Bayne-Jones is chairman of the sub-committee for the other four societies referred to above.

APPOINTMENT of seven chemists as a committee of direction for the National Institute of Chemistry, recently founded by the American Chemical Society, has been announced by Dr. George D. Rosengarten, of Philadelphia, president of the society. They are: Gerald L. Wendt, dean of the school of chemistry and physics, Pennsylvania State College; Professor Frank C. Whitmore, head of the department of chemistry, Northwestern University; Willis R. Whitney, director of the research laboratory of the General Electric Company, Schenectady, N. Y.; C. M. A. Stine, chemical director of E. I. du Pont de Nemours and Company, Wilmington, Del.; C. E. Kenneth Mees, director of research and development, Eastman Kodak Company, Rochester, N. Y.; Frederic W. Willard, Western Electric Company, Chicago. As already noted in SCIENCE, the first meeting of the institute will begin on July 4 at Pennsylvania State College and continue to July 30. A group of society officials, including the president, Secretary Charles L. Parsons, of Washington, and Dr. Harrison E. Howe, editor of *Industrial and Engineering Chemistry,* will aid the committee in arranging the opening sessions of the institute.

THE American Geophysical Union will hold its eighth annual meeting on April 28 and 29 at the National Academy of Sciences, Washington, D. C., with the following schedule of meetings: April 28—9:30 a. m. to 12:30 p. m., sections of geodesy and terrestrial magnetism and electricity.—2:30 p. m. to 5:30 p. m., sections of volcanology and oceanography. April 29—9:30 a. m. to 12:30 p. m., sections of meteorology and seismology.—2:30 p. m. to 5:30 p. m., general meeting of the union.

A GATHERING of the representatives of the dairy industry will take place in Washington on April 26, when the American Dairy Federation meets there. A two-day visit will be made to the Department of Agriculture, a number of bureaus of which are doing work of interest to the industry. Dr. C. W. Larson, chief of the Bureau of Dairy Industry, and Lloyd S. Tenny, chief of the Bureau of Agricultural Economics, will cooperate with the American Dairy Federation in preparing the program. Points of interest will be the dairy experiment farm at Beltsville, Md.; the research laboratories and the market milk investigation, dairy introduction and dairy engineering sections of the Bureau of Dairy Industry, and the livestock reporting, statistical, market news information and dairy marketing divisions of the Bureau of Agricultural Economics.

As already recorded in SCIENCE the Silliman lectures at Yale University will be given this year by Mr. Ernest Clayton Andrews, government geologist of New South Wales. The subject will be "Problems in Structural and Philosophical Geology; The Structural Unity of the Pacific Region." (1) The evidence of the present land forms. (2) The evidence of the older structural trends (general statement). (3) The evidence of the growth and structure of Australasia (detailed statement). (4) and (5) The origin of the mountains of the Pacific region, including the origin of the igneous rocks and the ore deposits. (6) The geographical distribution of the angiosperms, or the evidence for the permanence of the main Pacific (and other) ocean basins. The lectures will be delivered in the lecture room of the Sterling Laboratory of Chemistry, on May 2, 4, 6, 9, 11 and 13.

ACCORDING to the *Journal* of the American Medical Association, the section on surgery of the Royal Society of Medicine of England is arranging a post-graduate tour of the United States and Canada starting on July 23, and including Boston, New Haven, New York, Philadelphia, Baltimore, Washington, Cleveland, Detroit, Ann Arbor, Grand Rapids, Chicago, Rochester, Minn., the Great Lakes, Niagara, Toronto, Ottawa and Montreal. The facilities of the tour on the same terms will be offered to physicians not fellows of the society, if nominated by two members of the section and approved by the tour committee.

AN exhibition of epiphytes and houseplants was installed by the Brooklyn Botanic Garden at the recent international flower show at the Grand Central Palace, New York City, from March 21 to 28. Among the epiphytes shown were orchids, bromeliads, aroids and ferns, many of the species being recommended as house plants. A leaflet descriptive of the plants exhibited and setting forth methods for their culture was distributed.

AN entomological expedition, in which the Departamento Nacional de Higiene, Buenos Aires, and the British Museum of Natural History, London, participated, was recently effected in the little explored forested regions of northwestern Patagonia. The region investigated extended from Lago Nahuel Haupi, across the Andes to Puerto Montt, thence to Chiloe Island and from there northward into Chile until Santiago. The party consisted of F. W. Edwards (British Museum), M. F. Edwards, E. S. Shannon,

R. C. Shannon (formerly of the Department of Agriculture, Washington, D. C.) and E. Del Ponte (the last two being the members from the Departamento Nacional de Higiene). An attempt was made to collect all orders of insects, but particular attention was given to the Diptera. Representatives of fifty-eight families of this order were taken among which are many genera which are common only to Patagonia and New Zealand; some others are likewise common to these countries and to Tasmania and Australia as well. A more complete report will appear in the *Revista del Instituto Bacteriologico,* Buenos Aires.

## UNIVERSITY AND EDUCATIONAL NOTES

A GIFT of $25,000 has been made by Charles H. Ludington, of Ardmore, Pa., for the support of research work in the Henry Phipps Institute of the University of Pennsylvania during the year beginning July 1. The gift was made with the provision that the institute raise another $50,000 for research work.

A SCHOOL of dentistry will be established by Columbia University in a wing of the Columbia-Presbyterian Building on the Medical Center site at Broadway and 168th Street, New York. The teaching and practice of dentistry and oral surgery will be placed on the same professional basis as medicine.

THE will of J. Norris Oliphant, of New York, contains a provision by which Cornell University will receive an estimated sum of $150,000 on the death of certain relatives.

DR. FRANK J. GOODNOW, president of the Johns Hopkins University, has authorized the following statement in reference to the future of the School of Engineering: "Much interest has been displayed in the new plan for university work at the Johns Hopkins University. This plan applies particularly to the philosophical faculty. For the present, the school of engineering will continue as formerly to offer its regular four-year undergraduate courses and graduate instruction. Only such changes in curricula will be made as are necessary to conform with the modified courses in the college of arts and sciences."

DR. FOSTER E. KLINGAMAN, of the Johns Hopkins University, has been elected professor of physics in Ursinus College.

GEORGE C. WHEELER, assistant professor of zoology at Syracuse University, was recently appointed professor of zoology and head of the department of biology at the University of North Dakota.

WILLIAM T. PENFOUND, instructor of botany at the University of Illinois, has been appointed acting assistant professor of botany at Tulane University, to fill the vacancy caused by the recent death of Professor Cocks.

ASSOCIATE PROFESSOR H. B. CURTIS, of Marquette University, has been appointed head of the department of mathematics at Lake Forest College.

DR. SMILEY BLANTON, director of the child guidance clinic at Lymanhurst Hospital, Minneapolis, has been appointed professor of child study at Vassar College.

DR. GING HSI WANG, instructor at the Johns Hopkins University, has accepted a position as director of the institute of psychology at Sun Yet-sen University, Canton, China, and will leave about the first of May. Dr. Wang graduated at the Johns Hopkins in 1923 and has been instructor in the medical school for three years.

## DISCUSSION AND CORRESPONDENCE

### HELIUM IN DEEP DIVING

IN the issue of SCIENCE of January 14, 1927, there was published a statement by Mr. Elihu Thomson implying that the work carried out by the Bureau of Mines on the use of helium in the mitigation of caisson disease, published February, 1925, under the authorship of R. R. Sayers, W. P. Yant and myself, represents the utilization, without proper acknowledgment, of an idea which should have been credited to him. He concluded by saying: "If you have a good idea, publish it at once, or patent it, or both, in which case it is not so easy for the other fellow coming along years later to adopt it without giving credit where credit is due."

Mr. Thomson has published this aspersion without taking the trouble to ascertain the facts. So far as concerns my connection with the work carried on in the Bureau of Mines they are briefly as follows:

My studies in the theoretical aspects of the problem of solubility, extending over a number of years, made it evident that helium should be the least soluble of all gases, almost regardless of the solvent. Being familiar with the theory of caisson disease it was natural to think of utilizing the low solubility of helium in this connection by substituting it for nitrogen. I mentioned this possibility to Dr. R. B. Moore, then in charge of all helium work in the Bureau of Mines, while he was visiting Berkeley in the latter part of 1922, and was promised some helium for a few preliminary experiments. I made a formal request by letter to Dr. Moore on January 24, 1923, and

received a small quantity of the gas. I was, however, unable to pursue the intended experiments because of press of other duties, and submarine disasters suggested that delay in the development of this use of helium might result in loss of life which would otherwise be saved; realizing, furthermore, my own inability to carry on the large scale experiments that would be necessary, I decided to lay the matter before the Bureau of Mines. On January 29, 1924, I accordingly wrote to Dr. S. C. Lind as follows:

You have probably heard of caisson disease and the theory that it is caused by the release of dissolved gases in the blood as pressure is removed on coming out of the caisson, or, in the case of a diver, in coming up from a considerable depth of water. There is considerable physiological evidence in favor of this theory. This is the trouble which limits the depth at which diving operations are practicable.

Inasmuch as helium is only about one-half as soluble in water as is nitrogen, it has occurred to me that a diver breathing a mixture of oxygen and helium would be able to work at greater pressures or to come up from a greater depth more rapidly. I suppose that any oxygen dissolved as such in the blood could be readily disposed of by muscular effort and would not be a source of trouble. If helium is of service in this connection, it would obviously be of great economic importance in salvaging operations.

I had hoped to try a few experiments with mice, releasing them suddenly from a pressure of several atmospheres, using in one case air and in the other case a mixture in which helium replaced the nitrogen of the air. However, my time is so much taken up that there seems to be no very early prospect of trying such experiments. It has occurred to me, therefore, that this is a problem which the Bureau of Mines might like to investigate. The results, if successful, would doubtless be patentable, so that work should be done with due regard for protection. I am not desirous of making any money personally from such a venture, but I would hate to have any one else do so, and would want any profits used for scientific purposes. I will be glad to hear what you think of the prospect.

At this time I was altogether unaware that this use of helium had occurred to any one else, and certainly had no means of knowing what was going on in the mind of Mr. Thomson. The issuance of a patent to C. J. Cooke, on November 6, 1923, was unknown to me until a long time after, as I am not in the habit of perusing patent literature. While, therefore, my associates and I can not claim priority in publication, we are, I am sure, indebted to no one else for the idea.

J. H. HILDEBRAND
UNIVERSITY OF CALIFORNIA,
BERKELEY, CALIFORNIA

## DE KRUIF'S MICROBE HUNTERS

OUR attention has been drawn to a book called "Microbe Hunters," recently published by Harcourt, Brace and Company, New York, written by Paul de Kruif. The work evidently aims at being a kind of popular history or rather romance regarding medical discovery, and mentions us among others. We should like an opportunity to say, for the information of your readers, that the author's statements about ourselves and our researches are incorrect; that they are not supported by reference to the original literature; and that his knowledge of the subjects with which we have been concerned is obviously incomplete.

We have been legally advised that some of his assertions regarding ourselves are libellous according to British laws; but in America we have no means of protection except a public denial of the truth of his allegations, and we therefore trust that you will allow us to publish such a denial, as emphatically as we may, in your columns.

Dr. Cuthbert Christy's signature does not appear on this letter as he is in Africa; before sailing, however, he left us the following statement:

"With regard to Chapter IX of Paul de Kruif's book 'Microbe Hunters,' I beg to emphatically state that it contains statements which are totally erroneous and misleading. As an example I will quote paragraph 2, page 264, which reads: 'The third member (*viz.*, myself) became disgusted with the ignorance and failures of his two colleagues and went off prospecting for rubber. . . .' This paragraph is absolutely untrue. It suffices to say that I have always given credit to Castellani for his discovery of the trypanosome as the etiological agent of sleeping sickness—see, for instance, my letter to *The Morning Post*, August 22, 1923. As regards my abandoning my colleagues and going off prospecting for rubber, this is absolutely untrue. I never abandoned my colleagues, and, as a matter of fact, I did not get interested in rubber until 1906 which was three years after the labors of the First Sleeping Sickness Commission were completed."

ALDO CASTELLANI,
GEORGE C. LOW,
DAVID NABARRO,
RONALD ROSS

## PUBLICATION BY PHOTOGRAPHY

THE recent discussion of publication by photographic reproduction of typewriting (SCIENCE, Dec. 31, 1926; Feb. 18, Feb. 25, 1927) may warrant the following additional notes. The subject is well

worthy of serious study by those who have tabular data to publish, not only because it may be less expensive but also because it avoids all possibility of printer's errors and saves much time usually devoted to proofreading. I have been interested in this method for many years and have used it successfully in several instances, though not recently. A red copying paper used instead of black carbon paper proved just as satisfactory in the reproduction and the red copy was not easily soiled by accidental smudging. Carbon copies may be fixed with shellac solution or similar material. The difficulty of the typist not being able to see the copy as it is being made without use of ribbon can be satisfactorily avoided if certain makes of carbon paper are employed, the type impressions being faintly legible on the reverse of such papers. For one form of typewriter, frequently used by scholars, it is (or was a few years since) possible to secure rolled strips of carbon paper much like the regular ribbon, to be used in place of the latter. The same make of machine controls the type blow by means of a spring, so that perfect uniformity of impact is secured, no matter how the keys are struck, and it has interchangeable type shuttles, allowing the use of many sizes and styles of type and types of many languages. A ribbon may be used instead of copying papers without bad results if a large type is employed and the photographic reduction is great, for the "fringes" practically disappear with such reduction. In such cases a red ribbon has proved better than most black ones. A clearly typed page eight and a half inches wide may be perfectly reproduced as a zinc etching two inches wide or even still narrower and the reproduction is legible without the use of a lens. A reduction to three inches in width is perfectly satisfactory when ordinary typewriter type is used. Tabular matter prepared by hand, by a good draftsman using India ink, is even more satisfactory than typewritten copy and it will bear very great reduction. Erasures on the copy may be made by means of "white ink" (white water-color) but one must make sure that the material used photographs as white; some of the white inks on the market reproduce as black and their use in this way is disappointing. As has been mentioned by others in earlier contributions to this discussion, slight alterations are satisfactorily made by means of paper slips pasted on to the copy.

Those who are interested in this method of publication may be interested in the following references, in which examples of tabular matter thus reproduced may be found. Plant World **17**: 345 (1914); *ibid.* 19: 287 (1916); Physiol. Res. **2**: 341 (1921).

BURTON E. LIVINGSTON
JOHNS HOPKINS UNIVERSITY

SINCE my first note, in the issue of December 31, 1926, I have learned that the photographic reproduction of typewriting has been used quite extensively by the Carnegie Institution of Washington. For the marked success attained in printing by this method see, for example, Lehmer's "List of Prime Numbers," his "Factor Table of the First Ten Million Numbers" and Stager's "A Sylow Factor Table of the First Twelve Thousand Numbers."

During the printers' strike in New York a number of years ago several popular magazines were published by the photographic reproduction of typewriting—however, under conditions of incomplete development as to methods, equipment and personnel. The sphere of usefulness and limitations of the method, which is not well known to scientists though likely to prove of great importance to them, would probably be fairly well brought out if the experiences of those who have used it were put on record.

SEBASTIAN ALBRECHT
DUDLEY OBSERVATORY,
ALBANY, N. Y.

## ENCYCLOPEDIA OF THE SCIENCES

THE undersigned has arranged for publication through The Science Press of an *Encyclopedia of the Sciences,* which is planned to be a survey of science as complete as can be made. It appears that the large encyclopedias, such as the "Britannica," must sooner or later be divided into separate works treating the main lines of human interest and that the alphabetical arrangement must give place to a classification by subjects. The *Encyclopedia of the Sciences* will consist of more than one hundred separate volumes, each treating a special subject but together forming a systematic and completely indexed review of modern science. Such a series of volumes permits each to be published promptly when ready and to be revised when desirable. It also makes possible the purchase of a single volume, the volumes concerned with a special science or the entire work.

It is planned to publish volumes giving general surveys of each of the principal sciences—mathematics, mechanics, astronomy, geophysics, physics, chemistry, mineralogy, geology, geography, meteorology, paleontology, general biology, botany, zoology, physiology, anatomy, bacteriology, pathology, psychology and anthropology. These will be followed by volumes on the different departments or divisions of these sciences. There will also be volumes on the history of each science, with biographical sketches of scientific men. The question of the inclusion of the applied sciences and of subjects such as education, history, economics and philosophy is left open.

The plan of an *Encyclopedia of the Sciences* has long been under consideration. About twenty years

ago The Macmillan Company were ready to undertake the publication, but they wanted a ten-volume encyclopedia alphabetically arranged in place of the separate volumes which were an essential part of the proposal. Several leading scientific men, including Simon Newcomb, agreed to prepare volumes, but the cost and then the war led to postponement.

The editor will appreciate the cooperation of all men of science who approve the plan of making an *Encyclopedia of the Sciences* that will reflect adequately the great advances and dominant position of modern science. He will welcome suggestions and advice.

J. McKEEN CATTELL

GARRISON-ON-HUDSON,
NEW YORK

## SCIENTIFIC BOOKS

*Pflanzen als Gesteinbildner.* By JULIUS PIA. viii, 355 pp., 166 tf. Borntraeger, Berlin, 1926.

THE author has a well-deserved reputation as an authority on algae, particularly the fossil calcareous forms that bulk so large in the Alpine Triassic and of which geologists in this country have but a slight realization. Consequently, it is Pia's discussion of the algae which holds the most interest for geologists, paleobotanists and algologists. For all these as well as the general student he has produced a comprehensive, well-illustrated and well-indexed text, which is all inclusive, after the German manner, but, unlike some, this appears to cover the literature very well and to be thoroughly up-to-date.

The general scope and contents may be gathered from the following outline: Following a brief introduction there are chapters on bacteria and the simpler algae, followed by chapters on the higher unicellular calcareous and siliceous algae, a short chapter upon the rôle of unicellular plants in the formation of coal and petroleum, and a long and important chapter on those green, brown and red multicellular algae which form calcareous sediments.

Chapter 7, of over 150 pages, deals with mosses and vascular plants, the resulting sediments being considered under the broad headings "Calcareous" and "Coal." Much space is devoted to a rather exhaustive discussion of coal, its origin and history. This is somewhat discursive, and the author takes occasion to discuss the recent discovery of peat-forming plants in the mid-Devonian, world production of coal, peat bogs, lignite and hard coals, their geologic occurrence, chemistry and by-products. There is much of paleobotanical interest in this part of the book, including accounts of the morphology of the more important plant types from the Paleozoic to the Recent which have contributed to carbonaceous deposits.

Although the author is not exactly synoptic in his treatment, I imagine that the matter presented is exactly what the non-specialist or student versed in but a single aspect of the subject will be glad to have brought together in this convenient form.

Contrasted with the discussion of organic sediments in the "Treatise on Sedimentation," by Twenhofel, and others, published last year under the auspices of the National Research Council, it may be noted that the present work gives a much fuller and more satisfactory treatment in the sections devoted to bacterial action, calcareous and siliceous sediments. The fifty pages devoted to carbonaceous sediments in the American work, is however, much better done than Pia's much longer chapter, which was, perhaps, to have been expected.

The German work has essential bibliographies at the end of each chapter, and the elaborate account that is given of the part played by the lower plants in sedimentary processes will, I imagine, come as a surprise to most American geologists, for, in North America, outside the tropics and except for diatomaceous earth, scattered chara marls, etc., plants have not been recognized as having played such a conspicuous rôle in the formation of non-carbonaceous sediments as they have in Europe.

EDWARD W. BERRY

JOHNS HOPKINS UNIVERSITY

*The Salamanders of the Family Plethodontidae.* By EMMETT REID DUNN, Smith College Fiftieth Anniversary Publications, Northampton, Mass. xi + 1–441 pp., frontisp., 2 unnumbered pls., 86 figs. (distribution maps). 1926. $6.00.

SINCE the appearance of E. D. Cope's "Batrachia of North America" in 1889, there has appeared no synoptic work on the amphibia of this continent save the check lists by Stejneger and Barbour in 1917 and 1923. The numerous individual researches on American amphibians during the past thirty-seven years have resulted in the accumulation of a relatively large mass of literature, never adequately digested. Dunn's monograph of the Plethodontidae now fulfils this need so far as one important group is concerned, and in addition gives us much new information obtained by the author himself.

The Plethodontidae, as here considered, include fifteen genera and eighty-six species and subspecies of lungless salamanders, most of which are also gill-less after hatching. Most of the species occur in North America, either east of the Mississippi River or west of the Sierra Nevada-Cascade ranges. Thirty species of the Genus *Oedipus* occur in Central America and

northern South America, as far as Bolivia and Venezuela, while one isolated species (*platensis*) of the otherwise Californian genus *Ensatina* occurs in La Plata. Two species of *Hydromantes* in Italy and Sardinia constitute the only known Old World species, these being considered cogeneric with a species (*H. platycephala*) of the central Sierra Nevada.

The introduction (pp. 1–57) is an extensive discussion of general problems relating to the group.

For each species a complete chronological synonymy is given, including not only taxonomic, distributional and life history items but many references on embryology and morphology as well. In turn follow the type, type locality, range, diagnosis, formal description, comments on variation, measurements and habits, and often a paragraph discussing the relationships of the form under consideration. Habits are quoted *in extenso,* from all available sources, a feature to be strongly commended as making fairly complete accounts available to isolated students. A detailed list of localities and a map showing the range closes each chapter.

Espada's plate of *Ensatina platensis* (An. Soc. española Hist. Nat. Vol. IV) is reproduced as a convenience to other workers in the group.

There are few taxonomic novelties, as most of the changes in names or generic affiliation have already been announced in shorter papers by the author, and the essence of the grouping here presented has already appeared in Stejneger and Barbour's "Checklist." *Oedipus gadovii* Dunn (p. 437) from Xomelta on Mt. Orizaba is the only new form described. The author has studied at first hand all but one of the species, handling in all more than 12,600 specimens. The monograph represents ten years of labor upon a group in which relationships were by no means clear.

The only criticisms which might be levied against the book relate to certain mechanical features. A full bibliography would have been very helpful; searching for obscure references from a synonymy is not altogether easy. The table of contents relates only to genera and there is no index, in consequence of which the reader must hunt laboriously page by page for certain items. Only two unusual species are figured; outline or colored figures of at least generic types would have added greatly to the usefulness of the work. But dismissing these details, the reader finds excellent typography, a pleasing style and a wealth of interesting material. The book will long serve as the standard work of reference on its subject. Dr. Dunn and Smith College are to be congratulated on a worthy contribution.

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## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### A TECHNIQUE FOR ARTIFICIAL FEEDING OF SANDFLIES (PHLEBOTOMUS) AND MOSQUITOES[1]

IN the course of experiments carried on by the Kala Azar Field Studies Unit,[2] Peking Union Medical College, in the attempt to transmit kala azar by means of various species of Phlebotomus, it was found that one species, *P. sergenti,* only rarely developed the flagellates of Leishmania following natural feeds on infected animals. In attempts to overcome this difficulty advantage was taken of the fact that sandflies may drink liquids offered them (Waterston,[3] 1922) and a technique was devised for feeding them rich suspensions of Leishmania.

The apparatus consists of a short length of glass tubing, in one end of which is a cork vise for holding the sandfly. In the other end is a snugly fitting cork sphere drilled to hold the feeding pipette. This permits easy adjustment of the pipette in applying it to the insect's proboscis. The cork vise and pipette holder may be turned from ordinary cork stoppers. Our apparatus was made with the aid of lathe, tool-rest and chisel improvised, respectively, from a small electric motor, the arm of a dissecting microscope and a 45-degree scalpel. Both vise and holder are turned to fit individual pieces of glass tubing. The sharpened ends of a strip of sheet brass bent double are thrust into the newly turned cork and fastened as shown. The cork is then cut longitudinally with a razor, forming the two jaws of the vise. The vise, which is kept open by the spring when free, is held securely closed when thrust into the glass tube. The vise end of the tube should be flamed, but the other end should be left unflamed, as any constriction would compress the pipette holder which must fit tightly when in position with the tube.

Success in feeding sandflies is dependent on having the tip of the pipette properly made. It is essential that the opening be just large enough to admit the piercing stylets but small enough to exclude the labium, which is pushed back like a sleeve by the pipette. Each of the three Chinese species of Phlebotomus (*P. sergenti, P. major* var. *chinensis,* and *P. perturbans*) requires a different size of opening, within rather narrow limits for each. The

[1] Aided by grants from the China Medical Board of the Rockefeller Foundation.

[2] Charles W. Young, M.D., in charge.

[3] Annals Trop. Med. and Parasit., Vol. XVI, p. 69. 1922.

pipettes are made from pieces of capillary glass tubing of about 0.5 mm bore. The feeding end is flamed in a micro-burner until the opening is of the proper size, as determined in the first instance by actual trial on the insect, and later by comparing under a dissecting binocular with a tested pipette. The entrance canal should be short enough to permit the stylets to penetrate into the lumen of the pipette itself where they are bathed by a relatively large quantity of liquid, an important feature in connection with blood or serum suspensions, the surface of which dries quickly.

The procedure is as follows: The sandfly is etherized slightly and picked up by a leg with fine forceps. Using the cork vise with its spring as forceps, the wings are gently pressed together over the back, with the body close to and parallel with the surface of the cork. The vise with the immobilized insect, which quickly recovers from the anesthetic, is thrust into the glass tube, where it is securely held without further adjustment. Under a dissecting binocular the tip of the previously sterilized pipette is slipped over the stylets of the mouth parts, the labium folding at its base as the pipette pushes it back. This position simulates that assumed by the mouth-parts when the stylets pierce the skin in feeding naturally. The pipette is then manipulated so that the tip, with the stylets enclosed, carries the proboscis anteriorly, resulting in a bend at its base, thus accentuating the slight angle the proboscis normally makes with the head. This latter position was found to be essential for rapid feeding.

The free end of the pipette is then sterilized in the flame and a small drop of the suspension is allowed to run in. By means of another pipette fitted with rubber tube and mouth-piece this liquid is blown to the farther end, where it immediately surrounds the insect's stylets. Feeding usually begins at once and is completed within several minutes, at times within thirty seconds. It is necessary to use a fresh pipette for each insect as the minute opening is sealed by the drying of the suspension. Used pipettes may be washed by drawing water through them by means of a water suction pump.

The suspension commonly used was made as follows: Freshly defibrinated rabbit blood was centrifuged and the serum removed. Spleen tissue from a hamster heavily infected with Leishmania was ground up in this serum. A volume of spleen-serum suspension equal to that of the serum originally removed was then added to the rabbit corpuscles. Saline suspensions may also be used.

During the summer of 1926 over six hundred sandflies were fed by this method. After the considerable practice acquired in developing the technique the proportion of successful feeds was very high. The sandflies are not injured, and their subsequent behavior is quite comparable with that of naturally fed sandflies. Development of the flagellates of Leishmania was demonstrated in most of the sandflies fed with blood-spleen suspensions.

A similar method with certain modifications was successful in feeding mosquitoes (Culex). The apparatus is necessarily larger. The cork vise is cut so that the wings may be seized and held in approximately their normal position folded flat one over the other. The sandfly pipette is unsuitable on account of the length and flexibility of the mosquito's proboscis. Two pipettes are used, one fitting with the other with as little play as possible. They are made by drawing out capillary tubing to the proper diameter. The outer pipette should be broken off slantwise. Tips of both are smoothed in the flame. The outer one is slipped over the entire proboscis. The latter is thus held straight and the stylets enclosed within the labium lie approximately in the central axis of the pipette. The opening of the inner pipette is just large enough to admit the stylets but not the labium. As the inner pipette is slipped over the stylets the outer one is withdrawn slightly to allow for the bending of the labium which occurs as its tip is pushed back along the stylets. The suspension to be fed is then run in and further procedure is similar to that in the case of sandflies. Feeding experiments with mosquitoes were much less extensive than with sandflies, but served to demonstrate the feasibility of the technique.

This method could doubtless be adapted for feeding a variety of sucking insects in cases where other methods of artificial feeding, such as by means of membranes, fresh animal skin, etc., are uncertain or impracticable.[4]

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## SPECIAL ARTICLES

### EFFICIENCY OF PINHOLE PROBES[1]

BY far the most efficient probe thus far has been the conical quill glass cone, yielding as much as $s = 600$ ($s$ roughly in $10^{-6}$ atom) acoustic pressure

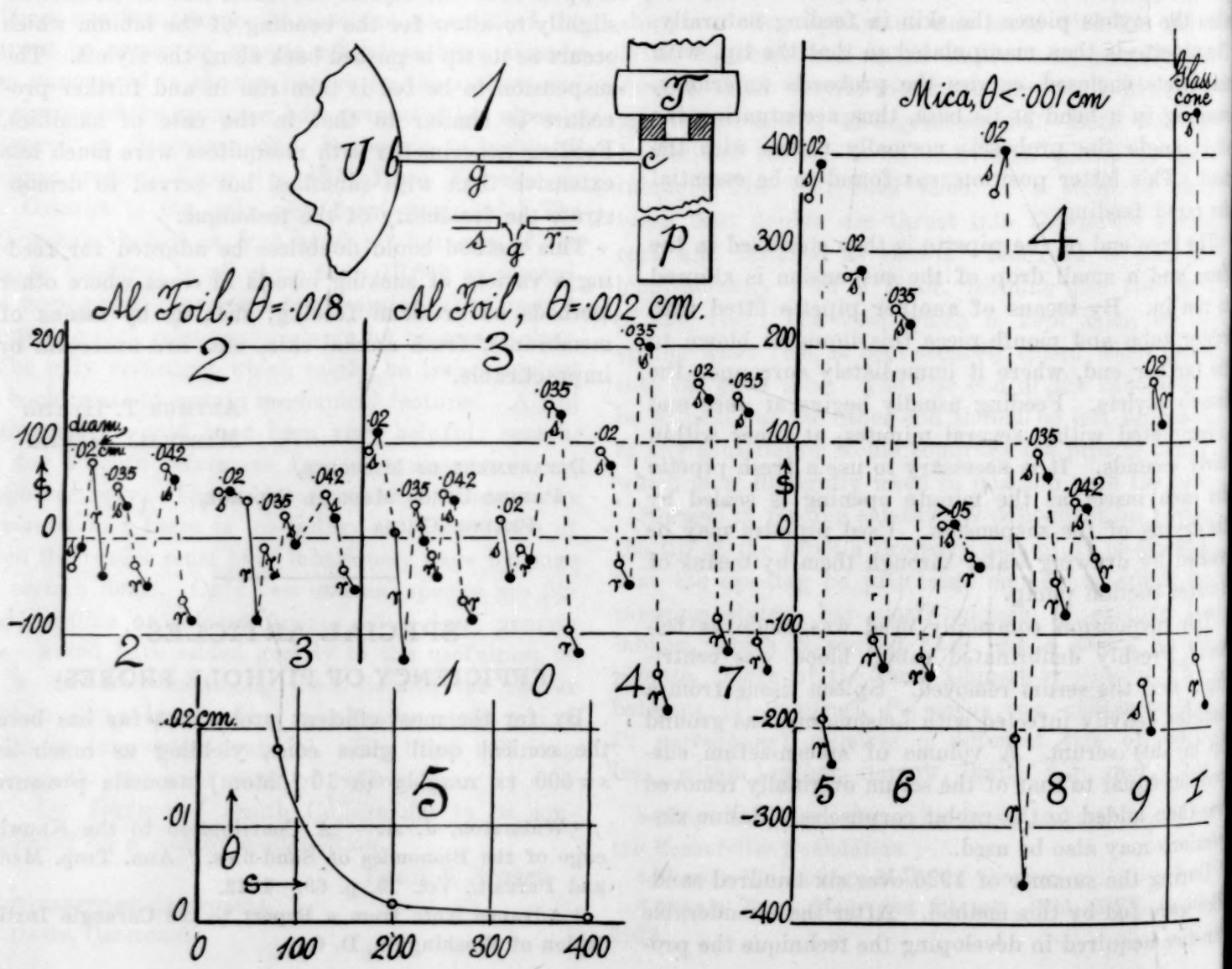
[4] Waterston, J. A. "A Contribution to the Knowledge of the Bionomics of Sand-flies," Ann. Trop. Med. and Parasit., Vol. 16, p. 69. 1922.

[1] Advance Note from a Report to the Carnegie Institution of Washington, D. C.

with the given telephone exciter, or sound intensity; or over four times as much as a good plate pinhole (caet. par.). The glass probe is essentially a hollow truncated cone, so that the oscillating air current strikes a sharp circular edge. Pressure is observed in the interior of the cone, and dilation (relatively) on the outside. If we imagined an air current toward the inside were converted into pressure, whereas an outward jetlike current were not, at least in the same degree, we should simulate the action of the probe. Being an embouchure the need of an optimum diameter of pinhole is implied; but it will presently appear that the need of a sharp edge is even more imperative, and it seems natural that there should be more vorticity on one side of the pinhole than on the other.

In many respects, however, the plate embouchure is more interesting, for here one can easily modify the bore and edge character of the pinhole, which in case of the glass quill tube cone has to be ground sharp to size. I have, therefore, given further attention to the simple plate device and the more important results are recorded in Figs. 2, 3, 4, the abscissas merely indicating the consecutive experiments. It was further found that the direction of the initial current in the telephone made considerable difference. Hence the latter is provided with a switch and its first position (I) is indicated by open circles, the opposite position (II) by black circles. It was thought that the difference was merely an expression of less efficiency of the telephone in the former case; but this is not true, as so many of the black circles are negative increments in $s$. In each case, the plate pinhole probe (plate on a quill tube 2 cm long, .35 cm in diameter) was tested both in the salient ($s$) and the reentrant ($r$) position in relation to the U-gauge (see Fig. 1). Diameters of the pinholes pricked by a fine cambric needle are also given. The very fine pinholes (diam. .02 cm) are singly too slow for convenient use. Finally the thickness, $\theta$, of the foil (plate) in which the pinhole is pricked from the outside of the tube is entered, making the record complete. Fig. 1 gives the adjustment of quill tube $bc$ with pinhole at $g$ to the pipe $p$ actuated by the telephone at $T$, and the interferometer U-gauge, U. Pipe, spring break of the circuit and electric oscillation are in tune with the relation of $bg$ (6.5 cm) to $gc$ (10 cm) corresponding to a maximum fringe displacement $s$.

Pinholes Nos. 2, 3, Fig. 2, are similar but of varying size. The diameter effect within its range is not



definite, showing that some other factor determines its behavior. The salient pinhole in position *I* is, as a rule, strongly positive; the reentrant behavior in position *II* more strongly negative, but there are many exceptions.

Pinholes Nos. 1, 0, 4, 7, Fig. 3, were punctured in much thinner aluminum foil, and the favorable effect of this is at once apparent in the improved efficiency of the probes. In other respects the remarks already made apply. Nos. 4, 7 were constructed with greater skill.

These experiments at once indicate the nature of the missing factor; for heretofore the thickness of the foil has been ignored. It is clearly of greater importance than the diameter of pinhole.

Following this suggestion I next pricked pinholes in mica plate, split as thin as admissible and much below .01 mm. The results in Fig. 4 show the enormously increased efficiency obtained, ordinates being given five times as large as those in Fig. 2, referring to the original thick foil. No. 5 was only examined for diameter .02 cm. In No. 6 there is but little difference between the first two diameters. In puncturing the third, the hole was accidentally frayed to about twice the area wanted and beyond the admissible range. Hence the low efficiency.

There is, however, always difficulty in successfully enlarging the pinhole. For instance, in No. 8 the original efficiency (diam. .02) is very large, particularly in the negative. On enlarging the bore to .035 and .042 cm, its sensitivity is nearly lost. No. 9 is another peculiar case, in which the fine pinhole is negative in the salient and positive in the reentrant position, a rare inversion of the usual occurrence.

The final graph shows the corresponding behavior of an efficient glass pinhole, one of the best. The fine hole mica probe is thus of the same order of excellence.

If we take the highest of the $s$ values corresponding to any thickness of foil $\vartheta$, and plot $s$ against $\vartheta$, we get a graph of hyperbolic contour, giving a mean estimate of sensitivity based on the results obtained. The smallest manageable thickness of plate is thus essential; in other words, the pinhole should be a sharp circle and anything of the nature of a capillary tube, however short, is detrimental. The viscosity of air is here liable to ruin the experiment.

And yet the two sides of the pinhole behave quite differently to the current of air propelled through it by the alternating nodal pressure. Hence the production of vortices at the pinhole by the acoustic pressures seems alone to account for the observed results. The oscillating air columns in contact and in opposite phases at the pinhole are successively shooting vortices into each other and the pressure difference results because, owing to the structure of the pinhole in question, one of the air columns does this more efficiently than the other. As the pinhole dominates, the hydrodynamic forces in pulsating media (Bjerknes) have no relevancy.

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## THE NUTRITION OF PLANARIAN WORMS

PLANARIAN worms exhibit differences in growth capacity according to their diet. They eat animal tissues with great readiness and show resulting variations in growth, depending upon the variety of tissue used and upon its condition as well. The worms thrive upon raw liver and have been kept indefinitely in our laboratory upon this as an exclusive diet. It was found,[1] however, that the power of liver to promote growth was diminished by heat and that the diminution depended upon the temperature to which the liver was subjected and upon the time of the exposure. Brain cortex is also an excellent food for the worms, and its power to promote growth is likewise diminished by heat.

In an attempt to determine whether the principle so important for the well-being of planarian worms could be separated from the intact tissue, the following procedure was employed. Liver from freshly killed guinea pigs was ground with sand and an equal weight of ether. The resulting paste was spread in a thin layer upon large glass plates and dried by an electric fan at room temperature for several hours. At the end of the drying the liver, which was in a highly friable condition, was ground to a fine powder in a mortar. It was then extracted five times with amounts of ether equivalent to the original weight of the liver, and the ether extract was evaporated with the electric fan. The product was a vaseline-like, brownish paste.

In all our experiments Planaria maculata was used. Each experimental group was kept in a finger bowl and consisted at the beginning of thirty worms. Since planarian worms multiply by fission neither average lengths nor number of worms alone could express the total growth, and it was decided to use as an index the total length of all the worms in a group. The length of the worms was estimated by placing them in a Petri dish over a piece of polar coordinated paper covered with a glass plate. As the worm glided along fully extended its anterior extremity was centered upon the center of the paper, and by following the movements of the worm with the Petri dish a really satisfactory estimate of the length of

[1] Wulzen, R., Univ. of Calif. Pub. Physiology, 1926, VII, 1.